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Effects of music listening on pre-treatment anxiety and stress levels in a dental hygiene recall population

Thoma, Myriam V ; Zemp, Martina ; Kreienbühl, Lea ; Hofer, Deborah ; Schmidlin, Patrick R ; Attin, Thomas ; Ehlert, Ulrike ; Nater, Urs M

Abstract: **BACKGROUND:** Waiting for a medical procedure can exert significant feelings of state anxiety in patients. Music listening has been shown to be effective in decreasing anxiety levels. No study so far examined the potential anxiety and stress-reducing effect of a music intervention on pre-treatment anxiety and stress in patients waiting for dental hygiene treatment. Knowing whether the anxiety-reducing effect of music would also be detectable in the context of preventive routine medical procedures in healthy individuals would widen the area of application of music from the hospital or clinical environment to medical offices in general. **PURPOSE:** Waiting for a medical treatment can induce anxiety and may lead to the experience of stress. We set out to examine the effect of music on pre-treatment anxiety in a healthy patient sample waiting for a dental treatment. **METHODS:** In a randomized controlled clinical trial, 92 consecutive volunteer patients (mean age, 57 years) waiting for their scheduled dental hygiene treatment were randomly allocated to either an experimental ($n = 46$, listening to music for 10 min) or a control group ($n = 46$, waiting in silence). State and habitual anxiety, subjective stress, and mood measures were assessed before and after music listening or silence, respectively. **RESULTS:** State anxiety levels in the music group decreased significantly after intervention as compared to the control group ($F(1/90) = 8.06$; $p = 0.006$). Participants' trait anxiety and dental anxiety were not found to moderate this effect. **CONCLUSIONS:** Listening to music prior to dental hygiene treatment decreases anxiety levels to a greater extent than waiting in silence.

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Running head: Music effects on pre-treatment anxiety and stress levels

**Effects of music listening on pre-treatment anxiety and stress levels in a dental
hygiene recall population**

International Journal of Behavioral Medicine

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1 *Abstract*

2 *Purpose:* Waiting for a medical treatment can induce anxiety and may lead to the
3 experience of stress. We set out to examine the effect of music on pre-treatment anxiety in a
4 healthy patient sample waiting for a dental treatment.

5 *Methods:* In a randomized controlled clinical trial, 92 consecutive volunteer patients
6 (mean age: 57 years) waiting for their scheduled dental hygiene treatment were randomly
7 allocated to either an experimental ($n = 46$, listening to music for 10 minutes) or a control
8 group ($n = 46$, waiting in silence). State and habitual anxiety, subjective stress, and mood
9 measures were assessed before and after music listening or silence, respectively.

10 *Results:* State anxiety levels in the music group decreased significantly after
11 intervention as compared to the control group ($F(1/90) = 8.06$; $p = 0.006$). Participants' trait
12 anxiety and dental anxiety were not found to moderate this effect.

13 *Conclusions:* Listening to music prior to dental hygiene treatment decreases anxiety
14 levels to a greater extent than waiting in silence.

15 *Keywords:* pre-treatment anxiety; music listening; dental hygiene treatment

1 *Introduction*

2 State anxiety is an adaptive emotional response to an individual's perception of a
3 (potential) danger in the presence of subjectively considered limited resources qualified to
4 efficiently deal with the actual situation [= stress, 1]. Waiting for a medical procedure can
5 exert significant feelings of state anxiety in patients [2]. Even in the context of minor medical
6 interventions or medical routine check-ups such as a dental hygiene treatment, levels of
7 anxiety can be markedly elevated [3]. (Pre-treatment) state anxiety involves a cognitive state
8 of increased sensory awareness (=alertness), worries, tension, uncertainties about the
9 outcome, lack of control, pain, and/or (anticipatory) perceived or actual threat to physical
10 integrity due to the approaching intervention [4, 5]. State anxiety¹ has to be distinguished
11 from trait anxiety, which describes the habitual way to respond to everyday situations (trait
12 anxiety) [6], or particular situations (e.g. dental anxiety) [7]. Importantly, anxiety also leads to
13 the activation of various stress systems, such as the hypothalamus-pituitary adrenal (HPA)
14 axis or the sympathetic nervous system [SNS, 8, 9], which in turn control the immune system
15 [10]. High levels of pre-treatment anxiety and the associated stress response may lead to
16 increased pain sensation [11] or treatment complications, inhibit or delay an optimal recovery
17 or increase post-treatment pain [e.g. 12, 13, 14]. Although pre-medication can be used to
18 relieve feelings of anxiety, pharmacological substances may induce unwanted effects or
19 paradoxical events, such as drowsiness, haemodynamic instability, agitation and
20 hyperactivity [see reviews in 15]. An effective, non-invasive and cost-effective intervention is
21 therefore sought, which will decrease pre-treatment feelings of anxiety and therefore
22 optimize the outcome of a medical intervention and increase the likelihood of an optimal
23 recovery progress.

24 Listening to music has been shown to alleviate anxiety and the associated stress
25 response in laboratory settings quite effectively [e.g. 16, 17-21]. Music also appears to be a

¹ When not otherwise stated , anxiety' refers to ,state anxiety'.

frequently chosen and effective tool in reducing anxiety in real-life settings where individuals experience lack of control or uncertainties about the outcome of personally important events, such as for instance before an exam or a sport competition [22, 23]. Listening to music has also been found to decrease intervention-associated anxiety / stress of hospital patients in clinical settings [e.g. 24, 25-32]. Specifically, with regard to pre-treatment anxiety, music has been applied in (ambulatory) hospital patients undergoing a variety of invasive medical procedures [for a review see 33]. It has been reported that listening to patient-selected [e.g. 34, 35-39] or investigator-chosen [e.g. 40, 41-43] music in the immediate pre-operative period for 10 to 40 minutes significantly reduces anxiety levels from before to after music listening as compared with a control group. Moreover, it was found that music listening decreases anxiety levels equally effective [44] or even to a greater extent [45] than the administration of benzodiazepines.

However, some of these studies suffer from methodological shortcomings, such as the lack of randomization, very small sample sizes, different treatment of control vs. experimental group (e.g. patients not wearing headphones in the control group), or very specific, i.e. homogeneous patient samples (e.g. only male patients undergoing transurethral resection of the prostate). Additionally, given that all of these studies have been conducted with (potentially) unhealthy individuals in (ambulatory) hospital environments, it may be that the patients' condition influenced the effect of music in an uncertain direction. What is more, the vast majority of these studies have either been conducted in the United States of America or in Asian countries: it may be that due to particularities of cultural differences in music tastes and in differences of the American and Asian health care systems, previous results might be culturally biased and findings may not be applicable to European samples. Indeed, the authors of a recent study with German dental patients found no clinically relevant effect of music on anxiety [46].

It would therefore be advisable to examine the purported pre-treatment anxiety reducing effect of music in an ostensibly healthy sample population undergoing a rather routine, yet still anxiety-inducing, medical procedure in Europe. A dental hygiene treatment

appears to be optimal to investigate the supposedly anxiety alleviating effect of music for several reasons: 1) Although less anxiety inducing compared to more invasive dental procedures, it still does induce anxiety [47], significantly more in females than in males but independent of age [48]. As we were able to show in a previous study, half of the patients waiting for a dental hygiene treatment reported significantly elevated anxiety levels [3]. Thus, alleviating anxiety in such a treatment, which is very common, has clinical relevance. 2) Individuals seeking dental hygiene treatment are not primarily seeking treatment for systemic disease(s), but rather for prophylactic purposes, which allows the examination of a homogeneous and assumingly healthy population, with almost no variance in the purpose why they seek treatment. To the best of our knowledge, no study so far has measured the potential anxiety and stress reducing effect of a music intervention on pre-treatment anxiety and stress in patients waiting for dental hygiene treatment. Knowing whether the anxiety-reducing effect of music would also be detectible in the context of preventive routine medical procedures in healthy individuals would widen the area of application of music from the hospital or clinical environment to medical offices in general.

We therefore set out to examine the effect of listening to music on pre-treatment anxiety and stress in a healthy patient sample waiting for a regularly scheduled dental hygiene treatment at a university dental clinic. We hypothesized that listening to music for 10 minutes would meaningfully decrease pre-treatment feelings of anxiety and stress.

1 *Methods*

2 *Participants*

3 Ninety-two participants were included in the current study. Participants were a
4 convenience sample of consecutive recall and / or maintenance patients recruited at the
5 Clinic of Preventive Dentistry, Periodontology and Cariology (ZZM) at the University of
6 Zurich. All participants had a regularly scheduled dental hygiene treatment appointment at
7 the clinic. The only inclusion criteria were: having a regularly scheduled appointment at the
8 ZZM, adequate German skills to follow the instruction and survey questions, and a minimum
9 age of 18 years. For their participation in the study, the subjects were reimbursed with a
10 music CD. The study procedure was conducted in accordance with the declaration of
11 Helsinki, and the study protocol was reviewed and approved by the ethics committee of the
12 Canton Zurich (SPUK, Zahnmedizin). All subjects provided written informed consent.

13 *Procedure*

14 *Prior to the appointment:* Patients of record at the ZZM, who were regularly scheduled
15 for a dental hygiene appointment were called by the main experimenters (MZ, LK) one week
16 prior their actual appointment. They were informed about the main purpose and procedure of
17 the study at the ZZM and were asked whether they would be interested in study participation.
18 After expressing their willingness, patients were asked to arrive 30 minutes in advance of
19 their scheduled appointment time.

20 *At the experimental day, prior to the dental hygiene treatment:* Patients were
21 welcomed by the main experimenter and taken to a separate area of the waiting room, where
22 they received a full description of the study. After agreement, all participants signed the
23 informed consent. The main experimenter then questioned the participant about
24 demographic information. By a computer generated randomization list, participants were
25 either assigned to the experimental (listening to relaxing music) or control (resting in silence)

condition. In both conditions lasting 10 minutes each, participants were wearing closed headphones. Before and after the experimental or control condition, participants completed questionnaires about state anxiety, subjective stress, anticipatory pain, and current mood (see below). After this, participants underwent their scheduled dental hygiene appointment.

At the experimental day after the dental hygiene treatment: After the treatment participants completed a trait dental anxiety questionnaire, were given the music CD, and were dismissed.

Treatment stimulus

As music stimulus, we chose the '*Miserere*' by Allegri (CD Gimell 454 939-2), which is a music piece that we already successfully used in several previous investigations [18, 49]. It is a Latin choral of 10 minutes that is soothing and calm in nature.

Psychometric Materials

Demographic information: Data was collected by the main experimenters about gender, age, education and occupation, native language, and number of previous appointments at the ZZM. For each participant, the dental hygiene examiner made additional qualitative and quantitative notes regarding previous appointments, the reason for the current treatment and the time period elapsed since the last treatment.

State anxiety: The state version of the *State-Trait Anxiety Inventory (STAI)* [50] was employed to assess the primary outcome of pre-treatment anxiety. The state-version of the STAI (STAI-S) contains 20 items and was used to detect possible changes in anxiety from before to after the intervention. Scores range between 20 (low anxiety) and 80 (high anxiety).

Habitual anxiety: The trait-version of the STAI (STAI-T) also consists of 20 items and was applied to assess anxiety as a trait. Scaling is the same as with the STAI-S. To assess trait anxiety levels with regard to dental treatment situations, the German *Hierarchical Anxiety Scale* [Hierarchischer Angstfragebogen, HAF] [7] was used. It consists of eleven

1 anxiety-inducing dental treatment situations, which have to be answered on a five-point scale
2 ranging from “not at all anxious” to “petrified”. High scores imply high dental anxiety.

3 *Stress*: A visual analog scale (VAS) was used to measure subjective perception of
4 stress (“I feel stressed in this moment”) twice, i.e. prior and after the experimental and control
5 condition, respectively.

6 *Mood*: The *Multidimensional Mood State Questionnaire* [Mehrdimensionaler
7 Befindlichkeitsfragebogen, MDBF] [51] was applied to assess potential changes in current
8 mood. It consists of three different scales, i.e. *valence* (good vs. bad mood), *alertness*
9 (awake vs. tired), and *calmness* (calm vs. nervous).

10 *Statistical Analyses*

11 All data analyses were assessed by using PASW for Mac OSX (18.0) software
12 packages (IBM, Chicago, IL, USA). Kolmogorov-Smirnov and Levene’s test were used to test
13 for normal distribution and homogeneity of variance, respectively, in all dependent variables.
14 All reported results were corrected by the Greenhouse-Geisser procedure where appropriate
15 (violation of sphericity assumption) [52, 53]. The Bonferroni correction has been used in all
16 multiple comparison procedures. Due to significant violations to the assumption of normality
17 of most variables, all analyses requiring normal distribution were performed using non-
18 parametric methods. Descriptive analyses were used for the calculation of mean (M) and
19 standard deviation (SD). Mann-Whitney *U* and χ^2 -tests were used to assess potential
20 demographic differences between groups. Wilcoxon signed-rank test was applied to test the
21 effect of music and silence on the dependent variables (within group comparison). Analyses
22 of variance (ANOVAs) for repeated measures are relatively robust to the assumption of
23 normal distribution [54] and were computed to analyze potential treatment-by-time effects.
24 Change scores (delta) for the dependent variables were computed as subtractions from the
25 second minus the first score of the variable. For correlational analyses Spearman rho’s test
26 was used. The significance level for all ANOVA analyses were adjusted to $\alpha = 1\%$. For all

1 other analyses, the significance level was $\alpha = 5\%$. All results shown are means \pm standard
2 deviations (SD).

Results

Subject characteristics and randomization

No significant differences were found between groups with regard to demographic and clinical information, as well as regarding baseline levels of the dependent variables (see TABLE 1). Thus, randomization to group allocation was successful.

---insert TABLE 1 about here---

Effect of music on anxiety and stress

State anxiety: To test whether there is a difference in state anxiety between treatment groups over time, we first calculated a repeated-measures ANOVA and found a significant group difference over time (treatment-by-time interaction: $F(1/90) = 8.06$; $p = 0.006$). We then calculated Mann-Whitney U tests to compare delta values between treatment groups and there was a significant difference between groups indicating that listening to music was effective in decreasing anxiety ($z = -2.705$; $p = 0.007$). Finally, we calculated Wilcoxon signed-rank tests separately for the music and the control group. We found a significant effect of music listening on anxiety ($z = -3.985$; $p < 0.001$) when anxiety levels of participants in the music group were compared from prior ($M = 33.59$, $SD = 8.61$) to after ($M = 30.48$, $SD = 7.96$) the music intervention. Anxiety levels in the control group did not change ($z = -1.329$; $p = 0.184$; pre: $M = 31.85$, $SD = 9.15$; post: $M = 31.22$, $SD = 9.19$). Altogether, anxiety levels in the music group decreased by 9.26% from pre- to post-intervention while those in the control group decreased only by 1.98%.

---insert FIGURE 1 about here---

Perceived stress: We tested whether perceived stress levels differed between groups. We first calculated a repeated measures ANOVA: there were no significant differences between the two groups over time (treatment-by-time interaction: $F(1/89) = 0.147$; $p = 0.702$). Also with regard to the delta values, we found merely a weak trend ($z = -0.706$; $p = 0.099$).

1 When looking at the treatment and control groups separately, we found that music led to a
2 (marginally significant) decrease in perceived stress levels ($z = -1.664$; $p = 0.096$; pre: $M =$
3 13.87 , $SD = 15.41$; post: $M = 12.24$, $SD = 17.60$), while there were no changes detected in
4 the control group ($z = -1.465$; $p = 0.143$; pre: $M = 13.38$, $SD = 20.37$; post: $M = 10.65$, $SD =$
5 16.73).

6 *Mood:* Finally, with regard to mood, we found no significant treatment-by-time
7 interaction effects using repeated measures ANOVA (*valence*: $F(1/90) = 0.494$; $p = 0.484$;
8 *alertness*: $F(1/90) = 1.673$; $p = 0.199$; *calmness*: $F(1/90) = 0.107$; $p = 0.744$). Also with
9 regard to delta values, groups did not significantly differ (*valence*: $z = -0.456$; $p = 0.648$;
10 *alertness*: $z = -1.403$; $p = 0.161$; *calmness*: $z = -0.413$; $p = 0.679$). However, looking at
11 groups separately, we found that music led to a small increase in the *alertness* of participants
12 in the experimental group ($z = -2.775$; $p = 0.006$; pre: $M = 16.00$, $SD = 3.15$; post: $M =$
13 16.72 , $SD = 2.92$). No effect of music was found on the *mood-scales valence* ($z = -1.544$; p
14 $= 0.123$; pre: $M = 17.46$, $SD = 2.52$; post: $M = 17.83$, $SD = 2.32$) or *calmness* ($z = -1.562$; p
15 $= 0.118$; pre: $M = 16.54$, $SD = 2.93$; post: $M = 17.15$, $SD = 2.78$). In the control group, waiting
16 for 10 minutes in silence resulted in a better mood ($z = -2.869$; $p = 0.004$; pre: $M = 17.30$, SD
17 $= 2.81$; post: $M = 17.91$, $SD = 2.47$) and participants reported to be calmer after the 10
18 minutes resting period ($z = -2.182$; $p = 0.029$; pre: $M = 16.87$, $SD = 3.20$; post: $M = 17.33$,
19 $SD = 2.89$).

20 *Impact of habitual anxiety and mood valence*

21 We further examined the potential influence of trait anxiety (STAI-T) and dental
22 anxiety (HAF) on anxiety baseline values as well as on the anxiety-reducing effect of music
23 vs. waiting in silence. We found that in a dental treatment environment higher trait and dental
24 anxiety levels were associated with higher baseline state anxiety levels (STAI-T: $r = 0.611$; p
25 < 0.001 ; HAF: $r = 0.496$; $p < 0.001$). When looking at the anxiety reducing effect separately
26 for the music and the control group, we found that trait and dental anxiety had no influence
27 on the anxiety reducing effect within the music group (STAI-T: $r = -0.095$; $p = 0.536$; HAF: r

1 = - 0.164; $p = 0.281$), nor within the control group (STAI-T: $r = - 0.078$; $p = 0.609$; HAF: $r = -$
2 0.106; $p = 0.483$).

1 *Discussion*

2 In the current study the anxiety-reducing effect of listening to music was investigated
3 in patients shortly before undergoing a potentially anxiety inducing dental hygiene session.
4 We found that listening to music for 10 minutes was more effective in reducing state anxiety
5 than waiting in silence. No effect of listening to music was found with regard to subjective
6 stress or mood. While baseline anxiety levels were positively associated with trait and dental
7 anxiety, the anxiety reducing effect through music was independent of this influence.

8 This is the first study showing that pre-treatment listening to music reduces anxiety in
9 patients waiting for a dental hygiene treatment. Our finding of a decrease in state anxiety of
10 9.26% falls within the range reported by previous investigations (1.39 % - 27.59%) in clinic
11 and hospital patients undergoing various medical interventions [e.g. 34, 36-41]. Moreover,
12 our study results are in accordance with data from two very recent studies that also used a
13 10-min music listening intervention [43, 55]. Music interventions in previous studies ranged
14 between 15 and 40 min [2]. We may cautiously conclude here that a 10-min music
15 intervention is a sufficient time period to allow music to exert an anxiolytic effect. This is an
16 important finding as waiting periods in dental or other medical offices are rather short in time.
17 Future studies have to show whether even shorter periods of music listening might be
18 sufficient to decrease anxiety.

19 We did not find a change in the subjective stress measures in our participants after
20 the music intervention. We are not aware of other studies that have investigated the
21 influence of music on pre-treatment subjective stress. There is one study that has looked at
22 the influence of *pre-*, *peri-* and *post-*operative music listening on cognitive appraisal of stress;
23 the authors report that music led to an essential decrease in perceived stress levels as well
24 as increased the coping abilities of patients undergoing ophthalmic surgery [32]. However,
25 given that their patients received medication (alfentanil and midazolam), comparability of the
26 two studies is rather limited. We believe that a potentially stress-reducing effect of music in
27 our study might have been concealed by a floor effect, as pre-treatment stress levels of our

1 participants were relatively low. Given the importance of cognitive appraisal processes for
2 the subjective experience of and coping with stress [1], more studies are needed that include
3 cognitive stress measures in their protocol, as this will enable us to learn whether and under
4 what circumstances music might have an influence on cognitive appraisal and thus on
5 anxiety and stress.

6 How can the anxiety reducing effect through music listening be explained? Given that
7 is was not the primary aim of the current study to investigate the underlying mechanisms of
8 the effectiveness of music, we are left speculating about the hereunto undiscovered modes
9 of action. Several different theories or assumptions exist with regard to the underlying
10 mechanisms of music. The *Entrainment* theory posits that body rhythms are synchronized
11 through entrainment processes with low (under 80 bpm) and predictable rhythm of music,
12 ultimately resulting in lower adrenergic and neuromuscular arousal [56]. Given that our music
13 stimulus fulfilled this criterion, a decrease in the physiological arousal might have contributed
14 to the alleviation in anxiety. However, we did not measure cardiovascular activity in our
15 participants to verify this assumption. Another hypothesis claims that the anxiety reducing
16 effect of music may be mediated by the induction of positive emotions evoked by music that
17 “undo” negative emotions and the associated physiological arousal provoked by them
18 [‘undoing hypothesis’, 57]. According to this hypothesis, we re-tested our data for a group
19 difference in the association between anxiety and mood. Indeed, we found a significant
20 negative correlation between the anxiety-reduction and the increase in positive mood only in
21 the music and not in the control group (data not shown), which provides support for
22 Levenson’s theory. However, the lack of causality does not allow us to make final
23 conclusions about the direction of this association. The assumption of an increased
24 *perceived personal control* over a stressful situation through music listening may serve as a
25 further explanation for the beneficial effect of music [e.g. 58]. Yet, this may only apply for
26 individually chosen music in situations where personal control is restricted (e.g. on an
27 operating table). Listening to self-chosen, i.e. the participants’ “own” music, may give the
28 individual a certain feeling of control over the situation. For the current study, this explanation

1 may not apply as we chose a standardized music stimulus, which was unknown to the vast
2 majority of the participants. A further reason may be seen in the coping style of *distraction*
3 *through music*, i.e. the diversion of the attention away from negative stimuli [e.g. 59, 60, 61].
4 It is likely that this may have contributed to the anxiety-reducing effect of music in the current
5 study. However, we did not specifically test for the possibility of distraction. Finally, and
6 probably underlying all previously mentioned assumptions, the particular *brain activation*
7 *pattern of music*, which among other brain areas involves the limbic system that modulates
8 autonomic responses [62], that may be responsible for the anxiety-reducing effects of music
9 in our study. It is highly probable that a combination of all these factors best explain the
10 anxiety-alleviating effect of music listening. For an extended overview with regard to
11 mechanisms related to emotions evoked by music we would also like to refer to the extended
12 theoretical framework by Juslin and Västfjäll [63].

13 Our findings have to be discussed in the light of some limitations. First, our decision
14 to standardize the music stimulus, i.e. to expose all participants to the same piece of music,
15 which was unknown to the vast majority of the participants, can be regarded as a limiting
16 factor. However, we chose this approach for several reasons: Although Knight and Rickard
17 [64] reported that the effect of music on pre-stress anxiety remained significant regardless of
18 participants' liking of the stimulus, familiarity with it and whether or not they experienced the
19 music as relaxing, it is widely accepted that familiarity with a music stimulus increases
20 (emotional) effects upon the listeners [61, 65-67]. However, it may be that individual memory
21 and subjective associations associated with familiar music is responsible for the increased
22 effect and not the intrinsic qualities of the music itself, in which we were particularly
23 interested. Moreover, given our interest in increasing the relevance for clinical practice of our
24 study results, i.e. for the implication of music playing in the waiting area of medical offices,
25 we thought that an investigator-chosen stimulus would be more adequate to mimic the reality
26 of music in a waiting room as compared to patient-chosen music. However, given the rise in
27 the usage and the popularity of portable music devices, it will be of importance to compare
28 self-chosen with author-provided music stimuli in future studies as well. Another limitation of

1 the study is that due to the nature of the investigation, we were not able to blind our
2 participants to group assignment; our participants were aware of the research question, and
3 we cannot fully exclude possible influences by demand characteristics. Futures studies
4 should show whether music listening would also be of benefit when applied *during* dental
5 procedures, as more recent research already suggests [68]. It is also of importance to know
6 whether the effect of music exists only in adults or also applies to children and adolescents
7 [69]. Future studies will also have to investigate whether the fact that participants were
8 wearing headphones was salient to the anxiety-reducing effect of the music. In a previous
9 study where music was played through speakers in a dental office, no effect on anxiety levels
10 was found [70]. Also, given that the music was researcher-selected, participant liking,
11 familiarity or preference for classical music genre should be assessed in future studies in
12 order to adequately interpret the findings. Finally, considering the relative small change in the
13 anxiety levels the clinical relevance of our findings has to be critically appraised. Further
14 studies need to replicate this finding and test the association between changes in anxiety
15 and dental-related clinical outcome variables.

1 *Conclusion*

2 We found that participants who were listening to an investigator-selected music
3 stimulus for 10 minutes prior to dental hygiene treatment reported less anxiety than
4 participants who were waiting in silence for 10 minutes. No effects of music were found on
5 subjective stress or mood variables. We recommend earphones be made available for
6 patients to listen to music while waiting for their appointments, in an effort to decrease any
7 anxiety felt prior to dental hygiene treatment.

1 *Acknowledgements*

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3 University of Zurich. Grant no: 56233208 (MVT). We thank the survey respondents and
4 acknowledge the assistance of Adriana Giaquinto and Regula Bättig in organizing the patient
5 interviews.

1 *Conflict of interest*

2 Myriam V. Thoma, Martina Zemp, Lea Kreienbühl, Deborah Hofer, Patrick R.
3 Schmidlin, Thomas Attin, Ulrike Ehlert and Urs M. Nater declare that they have no conflict of
4 interest.

1 *Informed consent*

2 All procedures followed were in accordance with the ethical standards of the
3 responsible committee on human experimentation (institutional and national) and with the
4 Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all
5 patients for being included in the study.

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Figure 1

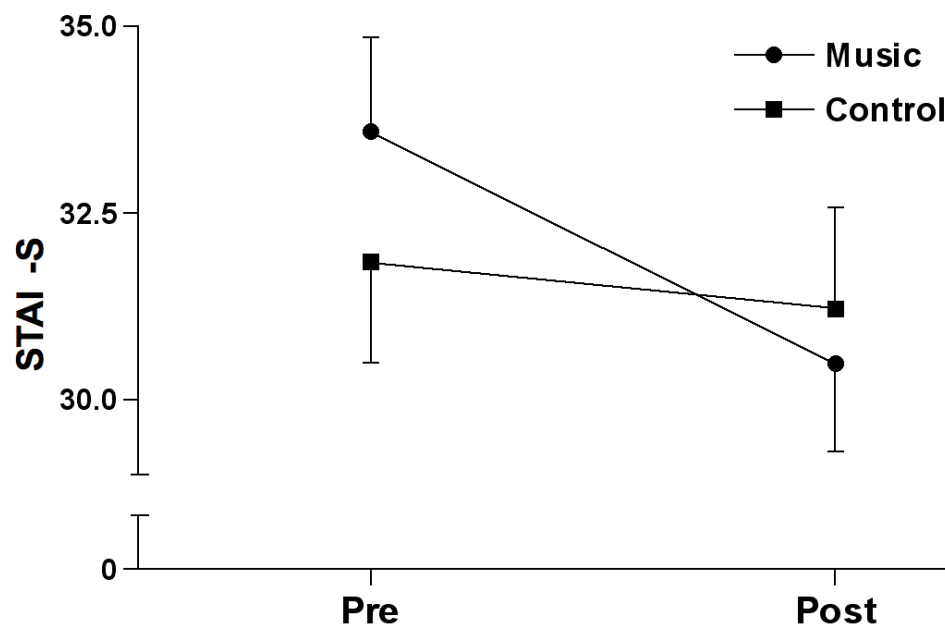


Figure 1: State anxiety (STAI-S) values pre- and post-treatment for the music and control group. A significant group difference over time was found ($F(1/90) = 8.06$; $p = 0.006$).

1 *Table 1*

2 Demographic and clinical information. Means, standard deviations (in parentheses), and
 3 group differences among study variables (N = 92)

	Experimental group (<i>n</i> = 46)	Control group (<i>n</i> = 46)	<i>z</i> (<i>p</i>)
Age	58.76 (13.52)	55.67 (12.36)	-1.102 (0.271)
Sex*	23 f (50%)	26 f (57%)	0.391 (0.532)
Years of education	13.56 (3.0)	13.93 (3.01)	-0.639 (0.523)
Number of appointments per year	2.46 (1.07)	2.33 (1.35)	-.983 (0.326)
Elapsed time since last appointment (in months)	5.98 (6.93)	5.96 (4.44)	-.526 (0.599)
Pre state-anxiety	33.59 (8.61)	31.85 (9.15)	-1.286 (0.198)
Pre subjective stress	13.87 (15.41)	13.38 (20.37)	-1.357 (0.175)
Pre mood-valence	17.46 (2.52)	17.30 (2.81)	-.056 (0.955)
Pre mood-alertness	16.00 (3.15)	15.89 (3.73)	-.063 (0.950)
Pre mood-calmness	16.54 (2.93)	16.87 (3.20)	-.740 (0.459)
Trait dental anxiety	34.6 (9.85)	31.76 (9.34)	-.016 (0.987)

4 *Note.* *Differences in sex distribution were computed using a chi-squared test; f = female

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Figure 1

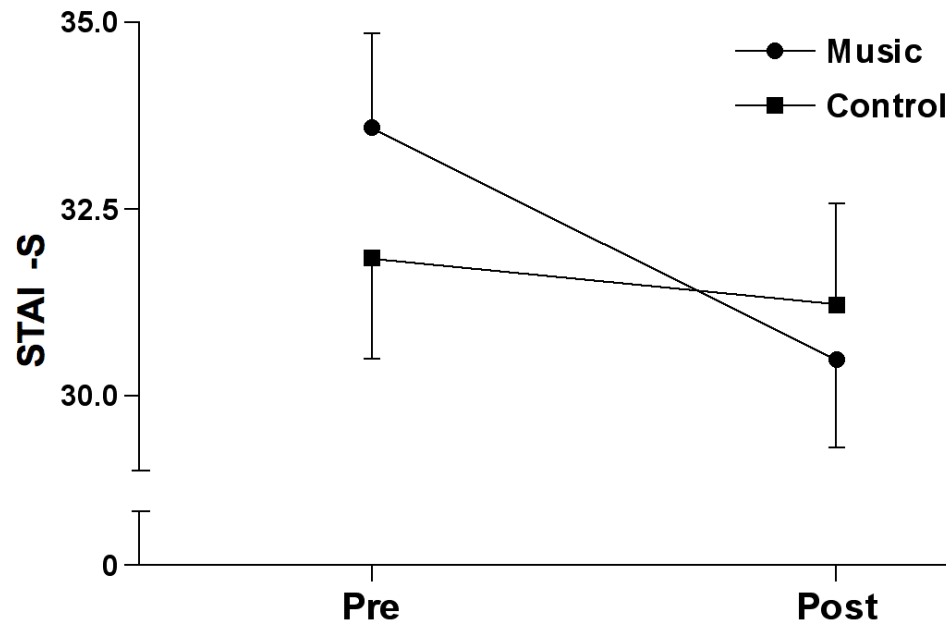


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